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FEDERAL EXPERIMENT STATION IN PUERTO RICO

of the

UNITED STATES DEPARTMENT OF AGRICULTURE

MAYAGUEZ, PUERTO RICO

BULLETIN No. 46

INSECT AND OTHER ANIMAL PESTS OF CINCHONA AND THEIR CONTROL IN PUERTO RICO

By

H. K. PLANK, *Entomologist*
and H. F. WINTERS, *Horticulturist*

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[1] In cooperation with the Government of Puerto Rico.

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WASHINGTON, D. C. FEBRUARY 1949

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By H. K. PLANK, *entomologist,* and H. F. WINTERS, *horticulturist*

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INTRODUCTION

Cinchona, the tree from which quinine and other antimalarials are obtained, was grown from seed in Puerto Rico as early as 1925 (*3, p. 564*).[2] However, the first successful field planting was made by the Forest Service in the Maricao Insular Forest in 1933 (*8, p. 91*). The growth of this planting was variable, and it was thought that lack of thrift in some species, particularly *C. ledgeriana* Moens, may have been caused at least partly by insect infestation (*9, p. 80*).

In 1935 the Maricao planting was turned over to the Federal Experiment Station for administration. During that year, this station began extensive introduction of *Cinchona* through the cooperation of the Bureau of Plant Industry, Soils, and Agricultural Engineering.

[1] Identifications of most of the species of animals mentioned in this bulletin were furnished by the Bureau of Entomology and Plant Quarantine.

[2] Italic numbers in parentheses refer to Literature Cited, pp. 16.

The area at Maricao (elevation 2,600 feet) was enlarged to accommodate both introduced and propagated material, and in 1943 an additional area (elevation 3,300 feet) in the Toro Negro Unit of the Caribbean National Forest near Jayuya was made available by the Forest Service for further experimental work. In the course of the studies that followed, a number of insect and other animal pests were encountered and some of them were noted to cause serious injury, particularly during early stages of growth.

Various insects have been reported on *Cinchona* in other parts of the Western Hemisphere, but so far as known none of these are now present in Puerto Rico. More than 20 species were found attacking the above-ground portions of the plant in Peru. These insects belonged to 7 families of Lepidoptera, 3 of Coleoptera, 1 of Orthoptera, 2 of Homoptera, and 1 of Hemiptera. Principally on account of natural enemies, no one species caused sufficient damage to make it a pest of real importance (*1, pp. 103–104*). Hambleton reported finding 2 species of insects of economic importance in Guatemala.[3] The mirid bug, *Poecilocapsus ornatulus* (Stal), was particularly damaging to nursery plants about 1½ to 2 feet high in open beds; and one species of thrips, later determined as *Isochaetothrips gardeniae* Crawford (*5*), caused considerable injury to younger plants in seedbeds during dry weather. Neither of these species is present in Puerto Rico.

Many pests have been reported from Java, and some of them are said to be serious enough at times to cause widespread damage, even under good cultural conditions (*14*). Among these, the most important appear to be: *Helopeltis antonii* (Sign.), a mirid bug that weakens the plant by sucking the sap from the leaves and is also a pest of tea (*2*) and cacao (*10, p. 50*); mites that attack the seedlings (*14*); and a number of defoliating caterpillars, principally *Attacus atlas L.* (*14*), *Boarmia crepuscularia* Hübner (*10, p. 55*), *Metanastria hyrtaca* Cresson (*10, p. 55*), and *Euproctis flexuosa* Snellenhoeven (*14; 10, p. 55*). In comparison, the pests of *Cinchona* in Puerto Rico seem to be less severe.

This bulletin records the insects and other animals that have been found on *Cinchona* in Puerto Rico and reports the methods that have been used to keep them under control. These pests are discussed in the order of their importance according to the following list:

LIST OF INSECTS AND OTHER ANIMALS FOUND ON CINCHONA AND THEIR NATURAL ENEMIES

THYSANOPTERA

Thripidae:

Anaphothrips (*Chaetanaphothrips*) *orchidii* (Moult.).
Dinurothrips hookeri Hd.
Heliothrips haemorrhoidalis (Bouché).
Scirtothrips longipennis Bagn.
Tryphactothrips angulatus (Hd.).

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[3] Memorandum, "Insect Pests of Cinchona in Guatemala," to Ralph H. Allee, Chief, Division of Latin American Agriculture, Office of Foreign Agricultural Relations, U. S. Department of Agriculture, Washington, D. C., from Edson J. Hambleton under date of August 5, 1944.

Aeolothripidae:
Franklinothrips vespiformis (Crawf.) (Predaceous.).

HOMOPTERA

Coccidae:
Ceroplastes cirripediformis Comst.
Coccus acuminatus (Sign.) of Green:
Parasite: An entomogenous fungus, probably *Hypocrella* sp.
Coccus viridus (Green):
Parasite: An entomogenous fungus, probably *Hypocrella* sp.
Howardia biclavis (Comst.).
Saissetia hemisphaerica (Targ.).
Pseudaulacaspis pentagona (Targ.).
Pseudococcus citri (Risso).

Aphidae:
Myzus circumflexus (Buckt.).
Toxoptera aurantii (Fonsc.).

Psyllidae:
Arytaina sp., near *A. cayayensis* Cald. and *Euceropsylla russoi* Boselli.
Parasites: *Alloxysta* sp. (Order Hymenoptera, family Cynipidae, subfamily Charipinae.)
Discodes sp. (Order Hymenoptera, family Encyrtidae.)

LEPIDOPTERA

Hyponomentidae:
Larvae of an unidentified moth.

Geometridae:
Microgonia vesulia var. *olivacea* Warren.

Sphingidae:
Xylophanes pluto (F.).

Hesperiidae:
Choranthus vitellius (F.).

ORTHOPTERA

Blattidae:
Periplaneta americana (L.).

Gryllidae:
Amphiacusta caraibea Sauss.
Anurogryllus muticus (Deg.).

Phasmatidae:
Antillophilus sp.
Aplopus achalus Rehn.
Dyme sp.
Dyme sp., apparently undescribed.
Lamponius portoricensis Rehn ?:
Parasites: New genus and new species in the tribe Actiini. (Order Diptera, family Larvavoridae.)
Megaselia scalaris (Loew). (Order Diptera, family Phoridae.)

Tettigoniidae:
Microcentrum triangulatum Brunn.

COLEOPTERA

Scarabaeidae:
Cnemarachis sp.
Cucujidae:
Telephanus pallidus Reitt.
Parasite: *Euplectrus platyhypenae* How. (Order Hymenoptera, family Eulophidae.)

ACARINA

Tetranychidae:
Tetranychus spp.
Galumnidae:
Neoribates sp. (?).

MOLLUSCA

Cyclophoridae:
Farcimen croceum (Gmelin).

MISCELLANEOUS

Earthworms.
Wild house cats.

THYSANOPTERA

Thripidae.—*Scirtothrips longipennis*, a small brown species with forewings black to the tips, and *Anaphothrips* (*Chaetanaphothrips*) *orchidii*, with brown wings, have caused more injury to *Cinchona* than any other insects thus far encountered. Both have occurred in the greenhouse at Mayaguez (elevation 50 feet) as well as in the nurseries at Maricao and Toro Negro (*13*, *p. 29*). The first species was usually the more abundant, but both generally attacked only small- to medium-sized plants.

Damage consisted in a rasping of the upper surface of the leaves, particularly along the midrib and large veins, that caused the leaves to curl downward. Where feeding was heavy the tissue in these areas turned silvery white to brown and the leaves became much wrinkled, ragged at the edges, and finally dropped off. If the infestation was not controlled, small plants in seedflats or beds withered and died, as shown in figure 1, *A* and *B*, whereas older plants that survived in nursery beds lost most of their leaves and made poor growth (fig. 1, *C* and *D*).

The relative abundance of moisture around the plants seems to have more influence on infestation by these two species of thrips than any other condition. The most injury in nurseries has been observed during the latter part of the dry season, about May or June, when the plants have been checked in growth by drought. After the wet season sets in, about August or September, injury subsides to almost nothing, except in beds protected from rain, as by glass or heavy palm-leaf shade. In open beds only thinly covered with palm leaves, plants 6 to 15 months old have been damaged little, whereas in beds better protected from rain 70 to 80 percent of the plants of the same age have suffered severely (*12*, *p. 21*). After reaching the nursery stage of development, the type of seedling seemed to influence its susceptibility, small stocky plants being much less infested than tall spindling ones. Certain progenies or strains also appeared to be resistant (*13*, *p. 30*).

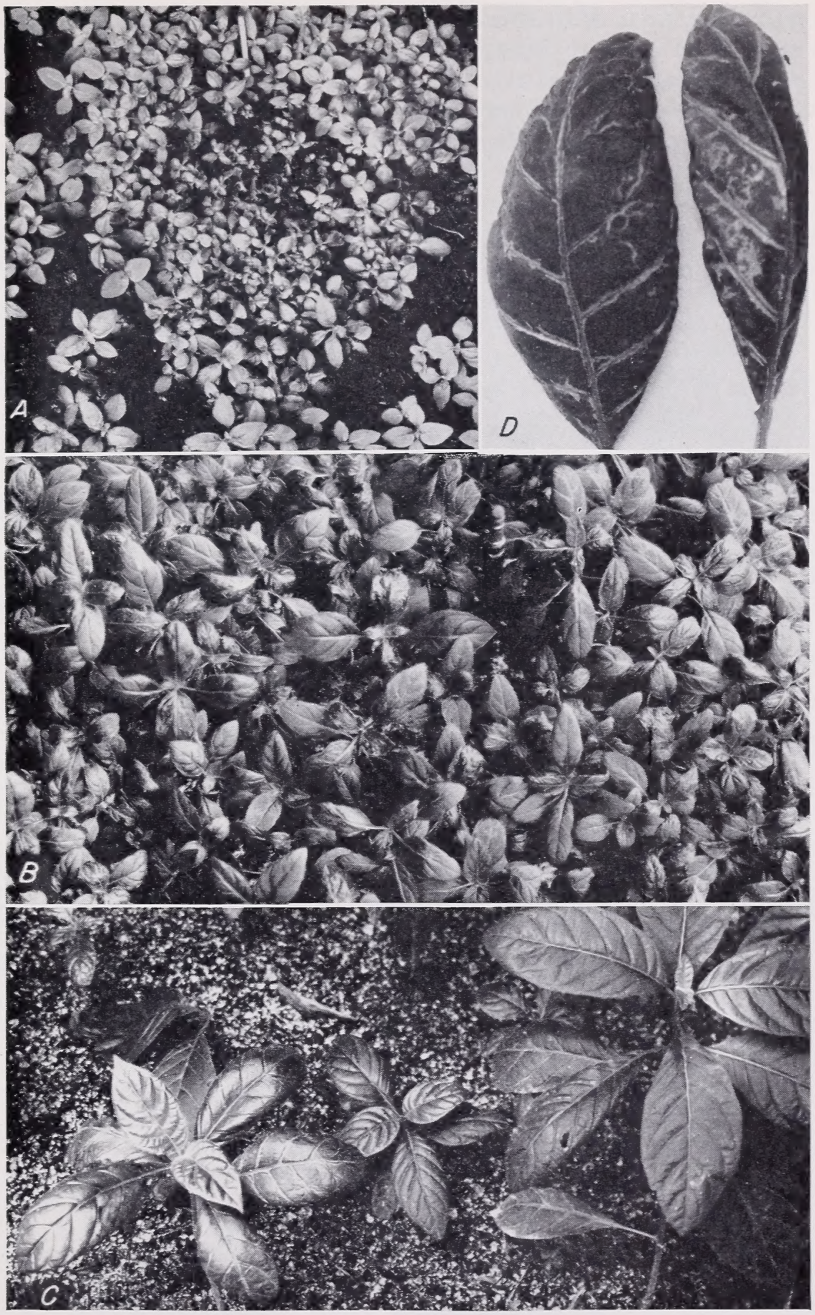

FIGURE 1.—Characteristic results of feeding by *Scirtothrips longipennis* and *Anaphothrips* (*Chaetanaphothrips*) *orchidii* on *Cinchona: A*, Withered and dying group of 4-month-old *C. ledgeriana* seedlings; note deformed and curled leaves on plants in center and wrinkling of others nearby. When not controlled infestation spreads throughout the whole flat or bed. *B*, 9-month-old seedlings showing severe attack on new leaves; note stunted growth and characteristically distorted leaves on plants in center. *C*, 12-month-old seedlings of *C. pubescens* Vahl in a nursery bed showing typical browning of veins and downward curling of lower leaves; the new, upper leaves developed after the infestation was controlled and are not injured. *D*, Detail of thrips injury shown in *C*. (*A* and *B* ⅓, *C* ⅙, and *D* ⅔ approximate natural size.)

The common black *Heliothrips haemorrhoidalis* (greenhouse thrips) began to appear at both Maricao and Toro Negro when the two foregoing species became reduced in numbers. It was first noticed on seedlings of *Cinchona calisaya* Wedd., about 25 percent of which were severely attacked. Older trees of this and other species, including *C. ledgeriana* in the same areas were also infested and some

FIGURE 2.—Results of feeding by *Heliothrips haemorrhoidalis* on leaves of 10-year-old tree of *Cinchona calisaya: A*, Branch showing loss of most of the old leaves from feeding on the lower surface indicated by light areas. *B*, Typical results of feeding on old and young leaves; note characteristic light areas on undersurface of old leaf at right and killing back of tip of young leaf at left; the margins and space between large veins on upper surface of old leaf in center were appreciably reddened. (White spots along midribs are the remains of scale insects attacked by a fungus.) (*A* ¼ and *B* ½ natural size.)

were partly defoliated (fig. 2, *A*). In contrast to the two foregoing species of thrips, this one fed almost entirely on the underside of the leaves, the effect on small plants, however, being practically the same. On older plants and trees, attacked areas turned whitish, then brown below and reddish above, as shown in figure 2,*B*.

Two other black species of thrips, *Tryphactothrips angulatus* and *Dinurothrips hookeri* were also found on *Cinchona ledgeriana* trees at Toro Negro. Like *Heliothrips haemorrhoidalis*, these two species confined their feeding to the underside of the leaves and with practically the same effect, but they occurred in much less abundance.

Aeolothripidae.—The common predaceous form, *Franklinothrips vespiformis*, was usually present, but in small numbers, wherever *Scirtothrips* and *Anaphothrips* were abundant.

Control.—Thrips infestations on young seedlings growing in flats or seedbeds are hard to control, chiefly on account of the tenderness of the leaves and the difficulty of thorough treatment. In the greenhouse at Mayaguez good control was secured with repeated applications of 40-percent nicotine sulfate 1–800 plus 1 percent of an emulsifiable white oil, and with a derris dust containing 1 percent of rotenone. In addition to these treatments, tartar emetic at the rate of 4 pounds to 100 gallons of water plus 16 pounds of sugar was tried in seedbeds and nurseries in the field. However, weekly applications of the 1-percent rotenone dust gave the best results and proved to be the most practicable for small plants under all conditions.

On account of the known toxicity of DDT to many species of thrips, a small test of this new material was made on some 4-year-old *Cinchona ledgeriana* trees at Toro Negro. These trees were lightly infested with *Heliothrips haemorrhoidalis*, *Tryphactothrips angulatus*, and *Dinurothrips hookeri*, and varied from 8 to 10 feet in height. A wettable powder containing 25 percent of DDT was used at the rate of 4 pounds in 100 gallons of water and applied with a knapsack sprayer on one side of each of five trees, the other side being left untreated for comparison. Nineteen days later an examination of an equal number of leaves from each side of all the trees showed a reduction in thrips population of 80 percent where this one application had been made. No injury to the leaves or any other part of the trees was apparent.

To see whether younger plants also would withstand this treatment, several hundred 2-year-old, 24-inch seedlings of *Cinchona ledgeriana* in nursery beds at Toro Negro were sprayed a maximum of three times at 2-week intervals. One lot of plants was held as a control, another was sprayed once, and two other lots were sprayed twice and three times, respectively. There were three replications of each treatment. At no time was any injury apparent on any of these plants, despite the fact that the residue from the DDT spray was heavy on many leaves and visible for a month following the last application.

It is important to note, however, that the same form and strength of DDT caused considerable injury on 2-inch seedlings of *Cinchona ledgeriana* in the greenhouse. The area of leaf tissue beneath the deposit left by accumulations of spray drops began to turn pink in about 10 days after application and changed to red during the next week. Where the deposit was somewhat heavy, the change in color penetrated to the under side of the leaves and the affected area died.

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The terminal bud on some plants was killed, but ordinarily in about 1 month a bud at the node immediately below germinated to take its place (fig. 3, *A*).

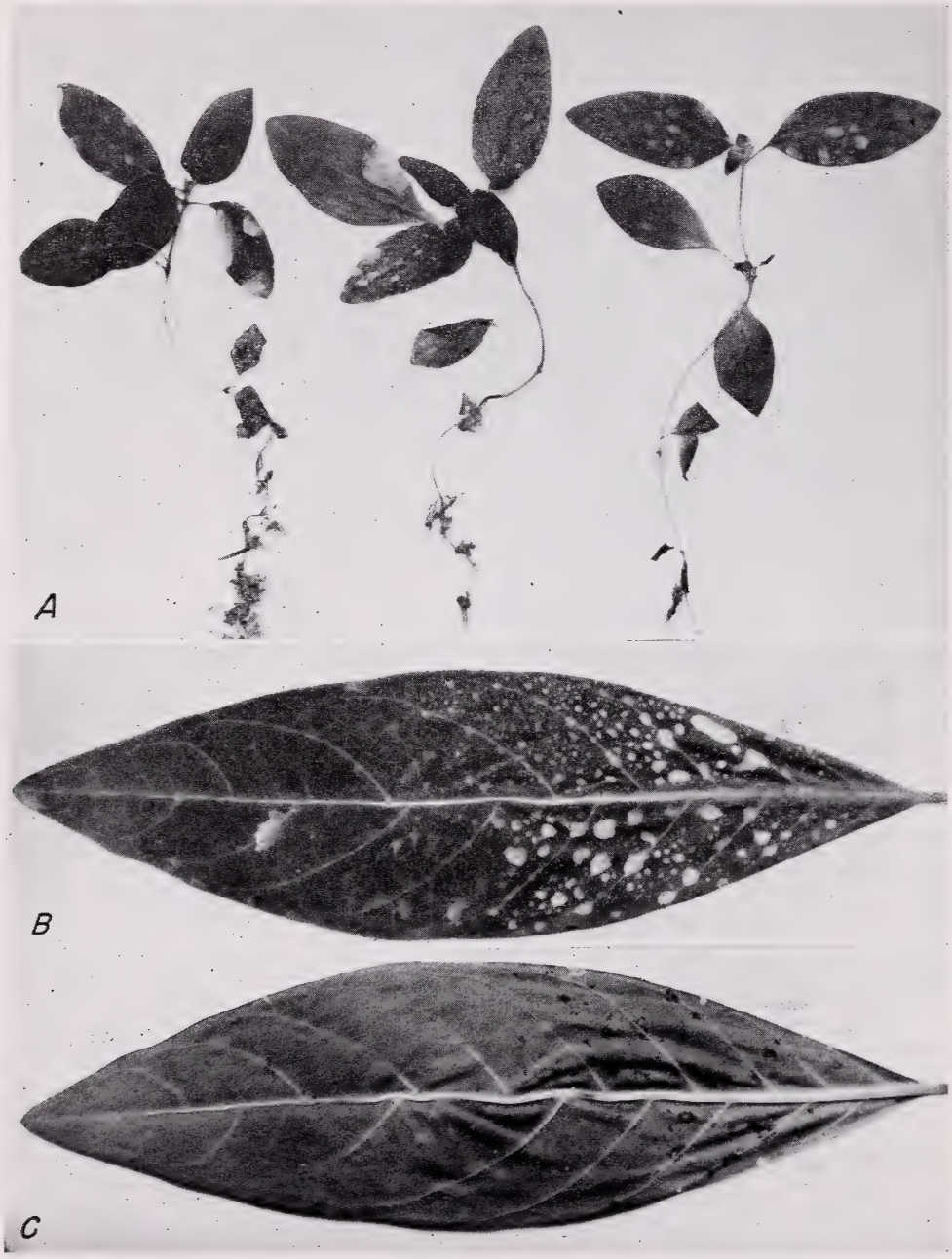

FIGURE 3.—Injury to leaves of *Cinchona ledgeriana* noticeable about 3 weeks after spraying under greenhouse conditions with DDT 25-percent, wettable powder 4 pounds in 100 gallons of water: *A*, 2-inch seedlings showing killing of leaf area beneath heavy spray deposits, particularly severe on plants at left; note terminal bud killed on plant at right and bud at node below germinating to take its place. *B*, Upper side of leaf from a 14-inch rooted cutting showing blotchy deposits beneath which the surface began to turn red in 10 days after application. *C*, Lower side of same leaf showing injured tissue (darkened areas). (⅔ natural size.)

A few 14-inch rooted cuttings of the same species having leaves about 5 inches long and growing in the greenhouse were also sprayed with this DDT material. Leaf injury of the same character was noted in about the same length of time, but, depending on the size of leaf, it was not so severe as that observed on the 2-inch seedlings, and the plants suffered no permanent injury (fig. 3, *B*). Greenhouse conditions may have been responsible for injury in both cases. However, until more information is available on the effect of DDT on *Cinchona*, it would be well not to use this new insecticide on small plants, either indoors or outside.

HOMOPTERA

Coccidae.—A number of species of scale insects, all previously reported from Puerto Rico on other hosts, have been found on *Cinchona* at various times, and some have caused considerable damage. The widely distributed green scale (*Coccus viridus*), which attacks the leaves and soft parts of the stem, was the commonest species on *Cinchona calisaya*, *C. ledgeriana*, and *C. pubescens* (*succirubra* Pavon). The last two of these seemed to be particularly susceptible to attack. An entomogenous fungus, probably *Hypocrella* sp., parasitized this scale (fig. 2, *B*) but apparently not until a sufficiently large population had built up to cause serious damage to young plants (*9*, *p. 80*).

The mining scale (*Howardia biclavis*) has probably caused more damage than any other scale insect, especially on *Cinchona ledgeriana*. Twigs and small branches on as many as 60 percent of the permanent trees and about 15 percent of those in the nursery at Maricao have been seen attacked at one time, and defoliation and killing of branches were common (*11*, *p. 21*).

Light infestations of the hemispherical scale (*Saissetia hemisphaerica*) have been observed on the twigs and leaves of various species of *Cinchona*. Heavy infestations have occurred on *C. pubescens* at Castaner and these resulted in the killing of some twigs (*11*, *p. 21*). The white peach scale (*Pseudaulacaspis pentagona*), common on a number of other plants in Puerto Rico, has occasionally been troublesome and was found in abundance on four species at Maricao (*9*, *p. 80*). The other coccids listed have been observed at Toro Negro and Mayaguez, principally on the leaves, but only occasionally and in numbers so small as to indicate minor importance as pests of *Cinchona*. Most of the *Coccus acuminatus* scales found at Toro Negro were attacked by a white fungus, probably *Hypocrella* sp.

Whenever scale infestations have required artificial control, satisfactory results have been obtained with applications of light oil emulsion at 1 percent plus nicotine sulfate 1–800.

Aphidae.—The crescent-marked lily aphid (*Myzus circumflexus*) and the locally common black citrus aphid (*Toxoptera aurantii*) were observed at Maricao in late October. Both species occurred in moderate numbers on the underside of the small center leaves of year-old seedlings in nursery beds. Between 5 and 10 percent of the plants were attacked, causing the leaves to curl and wrinkle abnormally. Sporadic aphid infestations have also been seen in the nurseries at Toro Negro. However, neither of these species was observed to gain headway or to cause any appreciable damage.

Psyllidae.—A few light-brown females of *Arytaina* sp., near *A. cayayensis*, were found on the underside of the leaves of 3-inch seedling *Cinchona ledgeriana* plants at Toro Negro in June. No damage that could be attributed to these insects was observed. Two species of hymenopterous parasites were reared from the specimens collected, namely *Discodes* sp. and *Alloxysta* sp. The members of the subfamily, Charipinae, to which the latter species belongs, are said to be hyperparasites of aphids (*4, p. 271*).

LEPIDOPTERA

Hyponomentidae.—The small, dark-brown, black-headed larvae of a dark-brown moth, genus and species undetermined, were responsible for the loss of a large number of 1-inch seedlings of *Cinchona succirubra* growing in sphagnum moss flats in the greenhouse at Mayaguez. The plants were cut off, usually in groups, at or just below the surface, the larvae taking shelter in lightly constructed, silky runways made into the moss nearby. These runways sometimes were littered with frass. Although difficult and time-consuming, control was obtained by hand destruction of the larvae in their runways.

Geometridae.—Large light-brown measuring worms, *Microgonia vesulia* var. *olivacea*, were found feeding extensively on the leaves of *Cinchona pubescens* at Toro Negro in August (fig. 4). The few larvae encountered were controlled by hand picking. Wolcott records this species on the leaves of wild orange and on *Acalypha wilkesiana* (*15, p. 452*).

Sphingidae.—The green larvae of *Xylophanes pluto* were found at various times from May to December feeding extensively on the margins of the leaves of seedling trees in the Maricao nursery. These larvae have never been numerous, and by hand picking it has always been possible to prevent damage. This species has previously been recorded as feeding on *Erythroxylon* and having been collected at Coamo Springs and Mayaguez (*15, p. 450*).

Hesperiidae.—The skipper, *Choranthus vitellius*, was reared from a single pupa found in August in a folded leaf of *Cinchona ledgeriana* in the nursery at Maricao. Damage was insignificant and feeding on this host may have been accidental. Wolcott records the collection of this species at Mayaguez (*15, p. 409*) and the rearing of moths from larvae feeding on the leaves of areca palm (*16, p. 124*).

ORTHOPTERA

A number of species of Orthoptera have been noted at various times to feed on the seed and leaves of *Cinchona* spp. in the greenhouse at Mayaguez and on *Cinchona* and other plants in or near the station nursery at Toro Negro. In some cases damage was insignificant but in others it was sufficient to indicate that the pests involved could be injurious under conditions more favorable for their development.

Blattidae.—Probably the species of Orthoptera most injurious under greenhouse conditions was *Periplaneta americana* (American cockroach). Large nymphs of this common roach destroyed from 25 to 30 percent of the freshly planted seed of *Cinchona pubescens*. The central thick part of the seed was the part most frequently eaten, the thinner part being left almost intact. Damage ceased after card-

FIGURE 4.—A large measuring worm, *Microgonia vesulia* var. *olivacea*, feeding on margins of leaves of *Cinchona pubescens*. Large area at lower left was consumed in a few hours. (Slightly more than 1½ times natural size.)

board tubes with phosphorus paste smeared on the inside were placed about the flats in which the seed had been sown.

Gryllidae.—Slim, half-inch, black-and-dark-brown nymphs of the cricket, *Anurogryllus muticus*, were found during March and August in small burrows made in the mica-propagating medium used for rooting softwood cuttings of *Cinchona ledgeriana* in the greenhouse. The burrows contained pieces that the crickets had cut from the tender leaves of the cuttings. Control was effected by daily inspection of the flats for openings to the burrows and destruction by hand of the crickets found inside. This insect has previously been reported from Culebra Island, Coamo Springs, and Cayey, attacking tobacco and vegetables in the field and in seedbeds (*15, p. 42*).

Nymphs of *Amphiacusta caraibea*, a light- and dark-brown mottled cricket having long legs and antennae, damaged 10- to 18-inch potted plants of *Cinchona ledgeriana* in the greenhouse at Mayaguez during June and November. The edges of the tender top leaves of a number of plants were eaten and the terminal buds on a few other plants were attacked and killed. Control was quickly effected by placing phosphorus paste baits near the infested plants, as used for cockroaches (see Blattidae, p. 10). Common in many parts of Puerto Rico as a household pest, this species is also known to attack a number of garden vegetables and other plants, particularly in the seedling stage (*15, pp. 43–44*).

Phasmatidae.—Orthoptera seen in largest numbers in and near the *Cinchona* nursery at Toro Negro were stick insects, so called because of the close resemblance of their narrow, nearly cylindrical bodies to small sticks or leafless twigs. Some of these stick insects were of definite species, mostly wingless, but others could not be determined beyond the genus. All seemed to cause the same kind of injury, namely eating out holes near or along the edges of the leaves, as shown in figure 5. The period of most frequent infestation was from June to December. Plants near wild vegetation were the first to be attacked and suffered the most. However, no species was ever so abundant that it could not be controlled, and serious damage was prevented by frequent inspection and hand collection.

Several species of *Dyme* seemed to be the most common of the stick insects found on *Cinchona* as well as on other nearby vegetation. One species, "apparently undescribed," varied from 4 to nearly 5½ inches in length and from green to deep fawn in color. Another was of about the same size but had a dark-brown color. *Dyme haita* (Westw.) a brown to gray-brown, wingless form about 3 inches long was taken on the leaves of low bushy plants, *Pilea* sp. probably *yunquensis* (Urban) Britton & Wilson, growing nearby, and could be considered as at least a potential pest of *Cinchona*. This species is listed by Wolcott as occurring at Bayamon, in a coffee grove at Lares, and on undetermined shrubs at Caguas (*15, p. 35*).

A species of *Lamponius*, probably *portoricensis*, appeared to be next in abundance. The specimens collected were from 2 to 3 inches long and varied from light green to bronze or dark brown in color. One specimen, a nymph, had short spines on the thorax and abdomen. Numerous flies of two species were reared from a few specimens that died shortly after collection. One of these species was the phorid, *Megaselia scalaris*, which is recorded mostly as a scavenger

FIGURE 5.—A phasmatid nymph (stick insect) and typical samples of its feeding on a leaf of *Cinchona pubescens*. Note holes eaten out at lower left and feeding on tip and along edges. Sometimes a much larger proportion of the leaf area is consumed. (About ½ natural size.)

(*15*, *p. 346*). The other represented a new genus and new species in the tribe Actiini, family Larvavoridae.

Several species of *Antillophilus* were taken on *Cinchona*, *Pilea*, and miscellaneous vegetation. *Antillophilus* sp., a light green, spiny form measuring from 1½ to 2 inches long, was the only one of these species taken on *Cinchona*. However, *A. restrictus* (Redt.), very similar to the preceding species, could be considered as also attacking *Cinchona*, as it was found on *Pilea* bushes growing close to plants showing typical phasmatid injury. This species is recorded as having been collected at Arecibo (*16*, *p. 40*).

Aplopus achalus was taken on the leaves of *Cinchona* and of nearby vegetation, including *Pilea*. Females of this species are rather conspicuous. Those collected measured from about 3 to nearly 5 inches in length and the body was colored mostly yellow green above and blue green below. The thorax, about ½ inch wide, was dark amber

in color and bore yellow-green wings, the first pair of which was about 3/8 inch long and the second pair slightly longer. *A. achalus* is listed by Wolcott as having been described from Puerto Rico (*15, p. 35*).

Tettigoniidae.—*Microcentrum triangulatum* caused a small amount of damage to plants in the Toro Negro nursery in October. Adults of this dark-green katydid were found eating the leaves of *Cinchona* hybrids that had reached the height of about 18 inches. Damage was not extensive and control was easily effected by hand collection. This species has been previously reported as feeding on a number of other plants in many places in Puerto Rico (*15, pp. 37–38; 16, p. 40*).

COLEOPTERA

Scarabaeidae.—*Cnemarachis* sp., similar to *Phyllophaga* spp. that attack sugarcane, was taken at Toro Negro in May. The light brown beetles, about 3/4 inch long, were seen issuing from holes in the ground about the base of a 3-year-old *Cinchona ledgeriana* tree. It is presumed that the larvae were feeding on the roots, although the growth of the tree did not appear to be affected. No other trees were found similarly attacked.

Cucujidae.—Considerable numbers of the small, flat, light-brown beetle *Telephanus pallidus* were found on the underside of the leaves of 3-inch *Cinchona ledgeriana* seedlings in the Toro Negro nursery in June. Numerous flat, slim larvae having prominent heads, and the small brown pupae of this species were also present. As no injury to the *Cinchona* leaves could be detected, it is probable that both the adults and the larvae were feeding on fungi that were growing on the leaf surface or on the organic matter on or in the soil, as has been suggested by Wolcott (*15, p. 222*). *Euplectrus platyhypenae*, a slim black wasp about 1.5 mm. long emerged in the cage in which the foregoing larvae and pupae were being reared. Wolcott records *T. pallidus* as occurring commonly under leaf sheaths of sugarcane and on dry banana leaves at various places in Puerto Rico (*15, p. 222*).

ACARINA

Tetranychidae.—Two species of *Tetranychus* have been serious pests on the underside of the leaves of small *Cinchona* seedlings in the greenhouse at Mayaguez. One species, dull yellow with two dark bars on the back, was first discovered on a group of 3/4-inch seedlings in June; about 5 to 10 percent of the plants were stunted and had leaves that were silvered, bleached, or dead. The other species, having a red-colored body, appeared on 3-inch plants in November. From 50 to 75 percent of the plants in four flats were injured and some died. Complete control of both species has been obtained with dusting sulfur, one application usually being sufficient. When thrips were also present ground derris root was added so that the mixture contained 1 percent of rotenone.

Galumnidae.—Numerous shiny, dark-brown to black mites of the species *Neoribates* have been seen frequently on the underside of the leaves of 3-foot trees of *Cinchona pubescens* at Toro Negro. These

mites have the appearance of small round beetles about 0.5 mm. in diameter. As no injury to the leaves or other parts of the tree was found, these mites were considered to be scavengers, feeding possibly on fungus or other organic material usually present on the plants.

MOLLUSCA

Cyclophoridae.—Snails of the species *Farcimen croceum* have been found at various times in prepared *Cinchona* seedbeds in the Toro Negro nursery. These semiconical, dextral snails with slightly convex whorls are mostly pinkish brown in color and measure about 1 inch long by about ⅜ inch in diameter. Damage has thus far been limited to entering and moving around in the leafmold planting medium and to the attendant destruction of germinating seedlings. These snails have never appeared in numbers so large that they could not be controlled by hand collection or the usual poison baits. Previously recorded from El Yunque (*6, p. 434*), this species was also collected in July 1937 by Armando Arroyo, late of this station, on Montoso Peak at an elevation of 1,700 feet.

MISCELLANEOUS

Earthworms.—Earthworms of undetermined species have sometimes caused trouble in nursery beds made of forest duff, a spongy, friable, humus material matted with tree roots. The worms impeded drainage and aeration by rapidly breaking down the organic matter in the duff and bringing up into the mixture large quantities of soil. Beds built over subsoil tended to remain uninfested for a much longer period than those built over topsoil. Damage was overcome to some extent by removing the topsoil before constructing the bed (*7, p. 4*).

Cats.—Wild house cats frequently do a great deal of damage in seedbeds and freshly prepared and planted nursery beds by scratching around in the loose planting medium. For complete protection it has been necessary to enclose the beds in wire netting.

SUMMARY

Thirty species of insects, three mites, and one snail have been found on *Cinchona* in various stages of growth. Several species of thrips caused severe damage to small seedlings but were held in check by repeated applications of derris dust containing 1 percent of rotenone. DDT was also effective, but injured seedlings 2 inches tall or smaller. Five species of stick insects and 4 of scale insects attacked both nursery and field trees, causing minor to moderate damage until controlled by hand picking or the application of oil emulsions. Four species of lepidopterous insects and a mite occasionally inflicted moderate to serious injury on seedlings up to 2 years of age; the former were effectively controlled by hand picking, the latter by the application of dusting sulfur. Two species of aphids were of minor importance. The snail was troublesome in leafmold seedbeds but was readily controlled by hand picking. Earthworms and cats caused some damage in nursery beds.

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